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Role of MRI and Doppler Sonography in Evaluation of Soft Tissue Masses: A Comparative Study

Authors
Dr Ashwani Tomar[1], Dr Dinesh Sharma[2*], Dr Susheel Pundir[3], Dr Vijay Thakur[4], Asha Negi[5]
[1]Professor, Department of Radiodiagnosis, IGMC Shimla (H.P.)
[2]Assistant Professor, Department of Radiodiagnosis, DYSPGMC Nahan (H.P.)
[3]Former Senior Resident, Department of Radiodiagnosis, IGMC Shimla (H. P.)
[4]Professor, Department of Radiodiagnosis IGMC Shimla (H.P.)
[4]Former Professor, Department of Radiodiagnosis IGMC Shimla (H.P.)
*Corresponding Author
Dr Dinesh Sharma
Assistant Professor DYSPGMC Nahan (H.P.) India
Email: *dineshss108@gmail.com*

Abstract
Introduction: *MRI is well established to provide excellent spatial and anatomical evaluation of soft tissue masses, however grey scale and Doppler evaluation may provide sufficient information to differentiate benign and malignant soft tissue tumours in good number of cases.*
Objective: *The objective of the study was to compare the role of grey scale and Doppler USG and MR imaging in soft tissue masses and correlating the diagnosis with final diagnosis based on histopathology for distinguishing benign from malignant soft tissue masses.*
Material and Methods: *The study was conducted in 25 patients presenting with soft tissue swelling on clinical examination. The patients were first subjected to sonographic evaluation followed by MRI. The results were compared with the final diagnosis established by histopathological / FNAC examination.*
Results: *For malignant masses, USG had 86% sensitivity, 100% specificity with a positive predictive value of 100% and a negative predictive value of 85%. For benign masses, USG had 100% sensitivity, 86% specificity with a positive predictive value of 85% and a negative predictive value of 100%. For malignant masses, MRI had 93% sensitivity, 100% specificity with a positive predictive value of 100% and a negative predictive value of 92%. For benign masses, MRI had 100% sensitivity, 93% specificity with a positive predictive value of 92% and a negative predictive value of 100%.*
Conclusion: *Purely cystic & nonvascular masses can be simply followed with serial USG or subjected to surgery without histopathology and further imaging. Large masses with PSV >50 cm/s, RI <0.5, irregular areas of calcification that are suspicious for malignancy may be subjected for MRI for presurgical detailed evaluation and staging. Final diagnosis of many benign masses like lipomas, nerve sheath tumors, haemangiomas, paragangliomas & soft tissue hydatid can also be highly suggested on MR imaging, which was slightly more sensitive than USG for benign as well as malignant masses.*
Keywords: *Soft tissue masses, Magnetic resonance imaging, Doppler Sonography.*

Introduction

Soft tissue masses are a large diverse group of pathological entities. Soft tissue is derived primarily from mesenchyme and, by convention, consists of skeletal muscle, fat, fibrous tissue, and the serving vascular structures as well as associated peripheral nervous system. Soft tissue tumors are classified histologically on the basis of

the adult tissue they resemble. Despite the pathologist's best efforts, however, approximately 5–15% of soft-tissue sarcomas cannot be further classified. Imaging of soft tissue masses requires a multimodality approach, with no single imaging modality being ideal for a particular tumor. The diagnostic evaluation should begin with radiographs of the mass or region which is frequently unrewarding; however the radiographs can provide invaluable information when positive. Ultrasonography is often performed as a first step in the assessment of musculoskeletal soft tissue masses. It can in fact confirm the presence of a lesion, even if of small size, and provides information on its size, location, margins, and internal structure. It is a useful adjunct, especially in differentiating cystic from solid masses. Combined colour and power Doppler ultrasound, as well as spectral wave analysis, may enable assessment of vascular architecture and altered flow in soft tissue masses. MRI is considered imaging modality of choice to evaluate soft tissue masses & it drastically affects the patient's surgical management. MRI can provide information for both diagnosis and staging and thus has emerged as the preferred modality for evaluating soft tissue masses. MR imaging has largely replaced CT as the technique of choice for preoperative staging of patients with soft-tissue masses.

Material and Methods

25 patients, 14 males & 11 females, ranging in age from 8-65 years, presenting with soft tissue mass were prospectively evaluated with plain radiographs followed by USG & MRI. The patients with soft tissue mass arising primarily from viscera were excluded. Ultrasound was done on GE RT-3200/Toshiba core vision pro-diagnostic ultrasound system SSA-350 machine with transducer of 6MHz-10MHz frequency. Grey scale as well as Doppler examination of the soft tissue masses was done. All cases were subjected to routine MRI on Siemens Magnetom Avanto 1.5 Teslamachine**.** T1- & T2 WI were acquired in axial, coronal & saggital planes followed by STIR & pre contrast VIBE images. Post contrast images were obtained in axial, coronal & sagittal planes after administering gadolinium-based agent intravenously by 18/20 G cannula with dosage of 0.1m mol / kg at rate of 2ml/sec followed by 10ml of normal saline with pressure injector.

Table.1 Frequency Distribution & Correlation of USG parameters with Final Diagnosis

USG Parameter	Benign(n=11)	Malignant(n=14	P Value
Largest diameter (cm) 0-5 5-10 >10	 5 5 1	 2 4 8	<0.005
Margins Well defined Poorly defined	 8 3	 9 5	>0.05
Origin Subcutenous Facial Intramuscular Mixed	 1 7 2 1	 2 3 1 8	>0.05
Nature Solid Cystic Mixed	 9 1 1	 13 0 1	>0.05
Echogenicity Hypoechoic Hyperechoic	 7 4	 5 9	<0.05
Calcification Present Absent	 1 10	 6 8	>0.05
Vascularity Vascular Non vascular	 8 3	 14 0	<0.05

Table 2: Distribution and correlation of MRI Parameters with final Diagnosis

Benign (n=11)	MRI parameter	Malignant (n=14)	p value
	Size		<0.05
5	<5cm	1	
4	5-10cm	4	
2	>10cm	9	
	Origin		
1	Subcutaneous	1	<0.05
8	Fascial	5	
2	Intramuscular	1	
0	Mixed	7	
	Margination		>0.05
10	Well defined	8	
1	Poorly defined	6	
	T1		>0.05
7	Homogenous	6	
4	Heterogenous	8	
	T2		
4	Homogenous	1	>0.05
7	Heterogenous	13	
3	TI signal intensity	0	
3	Hypointense	12	<0.05
2	Isointense to muscle	1	
3	Intermediate	1	
	Hyperintense		
	T2 signal intensity		
0	Hypointense	0	>0.05
0	Isointense to muscle	1	
1	Intermediate	10	
10	Hyperintense	3	
	Triple signal intensity		
1	Present	9	>0.05
10	Absent	5	
	Edema	4	
0	Present	10	>0.05
11	Absent		
	Hemorrhage		
0	Present	5	<0.05
11	Absent	9	
	Bone		
0	Normal	4	>0.05
11	Abnormal	10	
	N-V bundle		
4	Involved	3	>0.05
2	Displaced	7	
5	Not involved	4	
	Compartment		
7	Intracompartmental	4	>0.05
4	Extracompartmental	10	

p value <0.05 is statistically significant.

For malignant masses, USG had 86% sensitivity 100% specificity with a negative predictive value of 85%.For benign masses USG had 100% sensitivity, 86% specificity with a positive predictive value of 85% and a negative predictive value of 100%. USG was able to predict the exact histopathological diagnosis in 10 (40%) of masses & all were benign. For malignant masses, MRI had 93% sensitivity, 100% specificity with a positive predictive value of 100% and a negative predictive value of 92%. For benign masses, MRI had 100% sensitivity, 93% specificity with a positive predictive value of 92% and a negative predictive value of 100%. MRI was able to predict the exact histopathological diagnosis in 15 (60%) of masses (11 benign & 4 malignant).

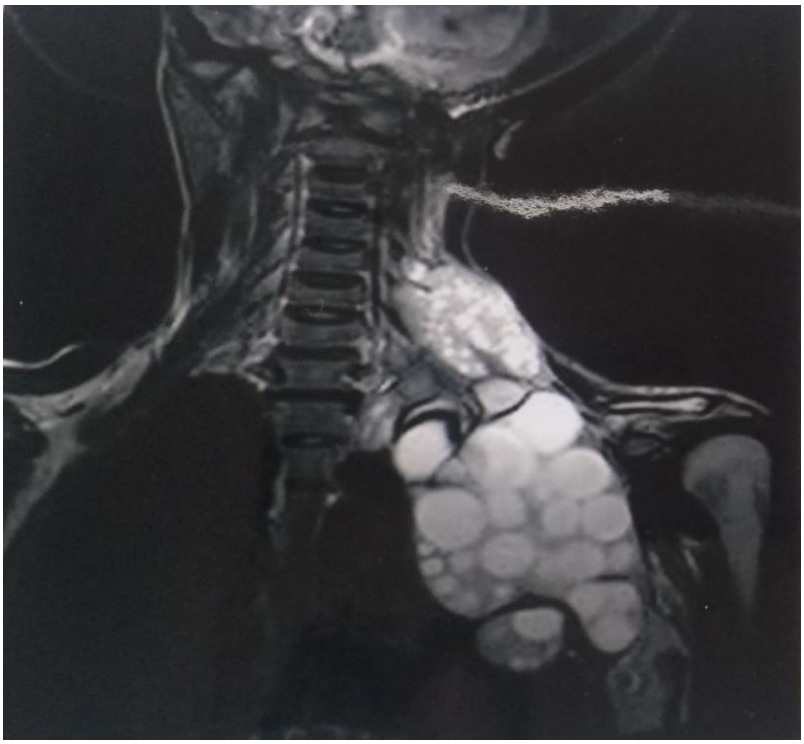

Fig.1 T2W coronal MRI image showing hyperintense daughter cysts in a case of extra pulmonary hydatid cyst.

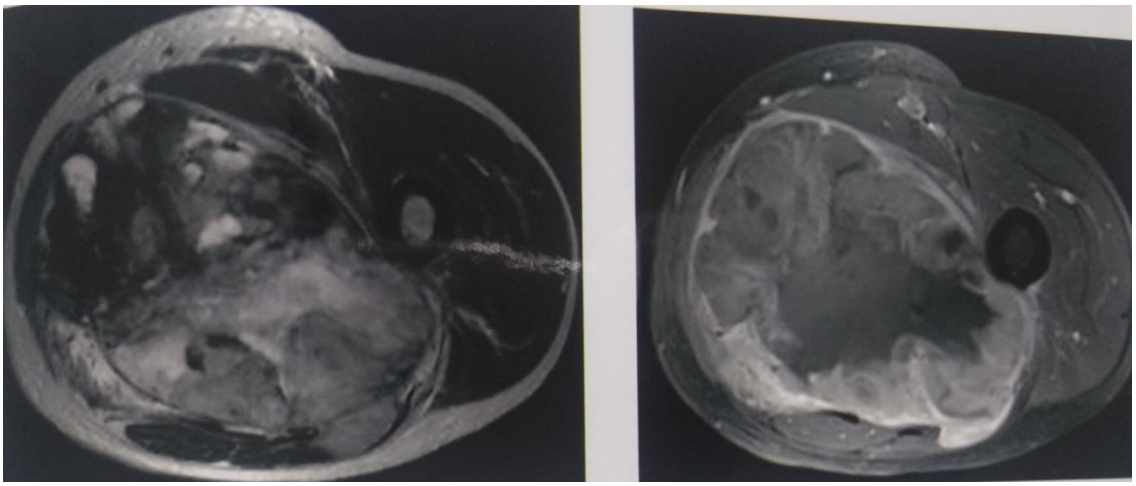

Fig.2 T2 axial image showing triple signal intensity and post contrast image showing heterogeneous enhancement with central necrosis in a case of malignant fibrous histiocytoma.

Discussion

Ultrasound

7(64%) of the benign & 5(36%) of the malignant masses were predominantly hypoechoic. 4 (36%) of the benign & 9 (64%) of the malignant masses were predominantly hyperechoic (p value of >0.05 which is not statistically significant). Therefore, echogenicity of the mass did not help in differentiating benign from malignant masses. Our study is at variance from the study by Belli et al[1], in which 86% of benign & 90% of malignant masses were hypoechoic while 8% benign masses were hyperechoic. All fatty tumors (4 cases) in our study were heterogeneous with echogenic lines parallel to the skin surface. This finding is consistent with the study by Ahuja et al[2] in which they had found all lipomas heterogenous with echogenic lines parallel to the skin surface.1 (9%) benign & 1(7%) malignant case showed homogenous pattern while 10 (91%) of benign & 13(93%) of malignant masses were heterogenous (p value of >0.05). 1 (9%) benign (hydatid cyst) &

6 (43%) malignant (2 synovial sarcomas & 4 MFH) masses showed calcification. The presence of calcification helped in making a diagnosis of malignant mass when other features also favoured the malignancy.3 (27.3%) of benign masses (2 lipomas & 1 hydatid cyst) showed no vascularity (p value of <0.05) and was statistically significant with a NPV of 100%. Presence of vascularity was not discriminating, since it was found in 8 of 11(72.7%) benign lesions as well as in all (100%) malignant lesions. Our result is in agreement with the study by Belli et al[1] in which they had also found absence of flow in only benign masses in 27.7% of cases with NPV of 100% while presence of vascularity was not helpful PSVs of benign masses ranged from 15-41 cm/s (mean 25.3±10.21). PSVs of malignant masses ranged from 15-81 cm/s (mean 37.8±19.55). 5 (36%) of malignant masses had PSVs greater than 50cm/s. None of benign mass had PSVs greater than 50cm/s. PSVs greater than 50cm/s had PPV of 100% for malignant masses, however it was not statistically significant with a p value of >0.05. Ozbek et al[3] had also found no statistically significant difference of PSVs among benign & malignant soft tissue masses. Belli et al[1] had however found PSV threshold of 50cm/s best suited for distinction of benign & malignant masses. The RIs of benign masses ranged from 0.28 to 0.76 (mean 0.56±0.14) whereas the malignant masses had RIs ranging from 0.38 to 0.91 (mean 0.59± 0.19). Considering the criteria of RI value of <0.5 for malignant masses was not statistically significant (p value of >0.05). However 6 of 8 masses with RIs of less than 0.5 were malignant. Our result is consistent with that of Kaushik et al[4] & Ozbek et al[3] as they had also found no statistically significant difference between RIs of benign & malignant soft tissue masses. Our result is in disagreement with the study by Bodner et al[6] in which RIs for all vessels measured, differed significantly between malignant (0.50 ±0.19) and benign tumors (0.79 ± 0.12; *P* <0.001). PI values did not show significant difference between benign & malignant masses consistent with the study by Belli et al[1].

MRI

On T1WI, 7(64%) of benign masses were homogenous & 6 (43%) of malignant masses were homogenous in signal intensity. On T2WI, 4 (36%) of the benign & 1 (7%) of the malignant masses were homogenous in signal intensity. 7 (64%) of the benign & 13(93%) of the malignant masses were heterogeneous. 3 (27%) of benign & 5 (36%) of malignant masses changed from a homogenous pattern on T1WI to heterogeneous one on T2WI. Presence of heterogeneity on T2WI and change in pattern from homogeneity on T1WI to heterogeneity on T2WI were not useful criteria in differentiating malignant from benign cases (p value >0.05) in our study. Our study is at variance from the study by Hermann et al[6] in which they had found 84% of the masses which changed from a homogenous pattern on T1WI to heterogeneous one on T2WI were malignant & the study by Pang et al[7] in which 72% of malignant lesions changed pattern between T1- & T2WI. Berquist et al[8] had found inhomogeneous signal intensity in 95% malignant & 24% of benign masses. On T1WI, 3 (27%) of benign masses were hypointense while 12 (86%) of malignant masses were predominantly isointense to muscle (p value of <0.05).On T2WI, 10(92%) of benign masses were predominantly hyperintense while 10(72%) of malignant masses were predominantly intermediate in signal intensity (p value of <0.05). 9(64%) of malignant masses & 1(9%) of benign mass showed triple signal intensity (intermediate, hypointense & hyperintense areas). Presence of triple signal intensity on T2WI was an useful criteria as it was statistically significant (p value <0.05). This triple signal intensity has been described in synovial sarcomas by Jones et al[9]. Sundaram et al[10]had also found hyper- & hypointense signal intensity in 3 cases of MFH. Perilesional edema was seen in 4 (28%) malignant while none of benign mass showed perilesional edema. Our result is consistent with the study by

Beltran et al[11] in which they found perilesional edema an useful indicator of malignancy. Our result is at variance from the study by the Kransdorf et al[12] & Berquist et al[8] in which both benign & malignant cases showed perilesional edema. Haemorrhage was seen in 5(36%) malignant masses with 4 of them showing fluid-fluid levels while none of benign mass showed haemorrhage (p value of <0.05). Our study is at variance from the study by Alyas et al[13]& Tsai et al[14] in which fluid-fluid levels did not reliably distinguish benign from malignant masses. Neurovascular bundle was involved in 4 (36%) benign & 3(21%) malignant masses. Displacement of neurovascular bundle was seen in 2(18%) benign & 7 (50%) malignant masses. Involvement of neurovascular bundle was not useful criteria & consistent with the study by Moulton et al[15]. Our study is at variance from the study by Pang et al[7], in which they found neurovascular involvement in 28% malignant masses but not in any of benign masses. Bone involvement was seen in 4(28%) malignant. None of benign masses showed bone involvement. Our result is consistent with the Pang et al[7] as they had also found bone involvement in 28% malignant masses but not in any of benign masses. Berquist et al[8]found bone involvement in malignant masses & desmoids tumors. Our result is at variance from the study by Moulton et al[14], in which masses with bone involvement were benign in 62% & malignant in 38% of cases 4 (36%) of benign & 10(72%) of malignant masses were extra compartmental. Involvement of compartment was not useful in differentiating a benign from malignant mass (p value of >0.05), however it was essential for staging a malignant mass as described by Peabody et al[16]. 8 (57%) of malignant & 2(18%) of benign masses showed peripheral enhancement (p value of <0.05). Our result is in agreement with the study by Rijswijk et al[17]& Van der Woude et al[17]. Van der Woude et al[18]found sensitivity of 73% and specificity of 97%based on peripheral enhancement for malignant masses. Our study is at variance from the study by May et al[19], in which MR scans with gadolinium did not contribute to differential diagnosis or patient management in 89% of patients. On MRI, 9(65%) of the 14 malignant masses were larger than 10cm & only 2 benign masses (1 simple lipoma & 1 lipoma variant) were larger than 10cm (p value of <0.05). 5(45%) of 11 benign masses & only 1(7%) malignant mass was less than 5cm (p value of <0.05). Similar results were observed in the study of Berquist et al[8] in which 87% of malignant masses were larger than 5cm and the study by Moulton et al[14], in which masses less than 5cm were benign in 86% cases. Rijswijk et al[16] also found large lesion size an useful MR parameter in predicting malignancy. On MRI, 10 (91%) of benign & 8 (57%) of malignant masses had well defined margins. 1(9%) of benign & 6(43%) of malignant masses had poorly defined margins. Margins of the mass was not a useful criteria (p value of >0.05) in differentiating benign from a malignant mass in our study as also described by Kransdorf et al[19]. They found 57% of benign & 63% of malignant masses had well defined margins. Rijswijk et al[17] also did not find the margins of the mass a useful predictor in determining benignity or malignancy.

Conclusion

Purely cystic & nonvascular masses can be simply followed with serial USG or subjected to surgery without histopathology and further imaging.

Large masses with PSV >50 cm/s, RI <0.5, irregular areas of calcification that are suspicious for malignancy may be subjected for MRI for presence of haemorrhage, perilesionaledema, neurovascular bundle & bone involvement for presurgical detailed evaluation and staging. Final diagnosis of many benign masses like lipomas, nerve sheath tumors, hemangiomas, paragangliomas & soft tissue hydatid can also be highly suggested on MR imaging some malignant tumours like MFH and synovial sarcoma can also be accurately diagnose.

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